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The Study Area

THE STUDY AREA INCLUDED all parts of Yellowstone National Park regularly used by the bison population, or frequented by them in the past 20-25 years (Fig. 1). The occupied bison range covers nearly half of Yellowstone's 3472 square miles, extending diagonally across the park from the northeast quarter to the southwest quarter. Some phases of study effort were emphasized in the northeast quarter. Lands outside the boundaries are not used to any extent by the park bison, and hence were not part of the study area, but they are discussed where pertinent to historical populations.

Physiography

Much of the park is plateau-like, varying in elevation from about 7000 to 8000 feet, and cut by large and small stream valleys (Fig. 2). Mountains project above the general level on all sides, but are less extensive in the interior. The Continental Divide traverses the park from west to southeast, generally unmarked by abrupt changes in terrain. Most of the study area lies east of the divide, and is drained by the headwaters of the Madison and Yellowstone rivers. Tributaries of the Snake River drain the southwestern corner.

Park geology is discussed by Hague (1899), whose work was followed by numerous topical studies. U.S. Geological Survey personnel are now completing a comprehensive research program which will add much to present knowledge of the complex geologic history of Yellowstone. Extensive volcanism, of which the widely distributed thermal activity is a remnant stage, has shaped many of the physiographic features. Effects of glaciers, which may have persisted as recently as 8000 years ago, are evident throughout the park.

The study area was subdivided into nine regions. From northeast to southwest these are: Lamar, Upper Lamar, Mirror Plateau, Pelican, Hayden Valley, Firehole, Madison Plateau, Pitchstone Plateau, and Bechler (Fig. 1). The Lamar (Fig. 3), at approximately

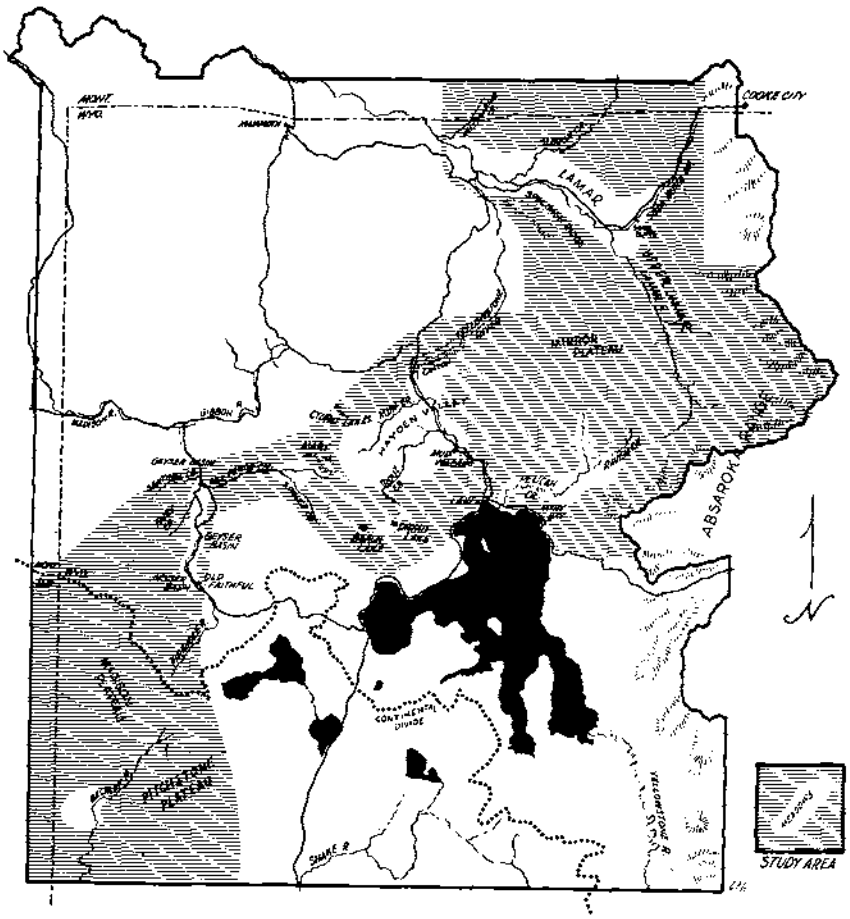

Fig. 1. Map of Yellowstone National Park showing study area.

6400 feet, includes lower Hellroaring and Slough creeks, the main Lamar River Valley below Soda Butte Creek, the north-facing lower slopes of Specimen Ridge, and the Soda Butte area. The Upper Lamar refers to the Lamar River above Soda Butte Creek, together with the ridges and tributaries rising eastward to the Absaroka Mountains, at more than 10,000 feet (Fig. 4). The Mirror Plateau, including much of Specimen Ridge, lies between the Lamar

Fig. 2. Aerial view of a part of the forested plateau, located centrally.

River to the north and east, the Yellowstone River to the west, and Pelican Valley to the south. Pelican Valley (Fig. 5), at 7800 feet, refers to the main valley from the lowest portions of Raven Creek to the mouth of Pelican Creek and includes Mary Bay on Yellowstone Lake. Hayden Valley, elevation 7700 feet, is centrally located in the park (Fig. 6). It extends from the Grand Canyon of the Yellowstone south to the Mud Volcano, west to Mary Mountain, and includes Beach and Dryad lakes to the south and Cygnet Lakes to the north. The Firehole, at 7200 feet, refers to all three major geyser basins along that river, together with Nez Perce, Spruce, Sentinel, and Fairy creeks (Fig. 7). West of the Firehole, the Madison Plateau rises gradually to the Continental Divide and extends to the Bechler Meadows. The Pitchstone Plateau (Fig. 8) lies southeast of the Madison Plateau. The Bechler Meadows, at 6400 feet, are comparable to the Lamar in elevation.

Soils vary greatly. Generally, there are deep silts in the bottoms of the big valleys. Morainal materials are especially prominent in Lamar. Lake deposits of clays and

Fig. 3. Springtime view west across part of the bison winter use area of the lower Lamar Valley.

Fig. 4. The upper Lamar drainage with the edge of the Mirror Plateau to the right, a part of the Absaroka Mountains in the background.

Fig. 5. Bison on the Pelican Valley winter range.

Fig. 6. A part of the Hayden Valley winter range with Alum Creek in the foreground.

Fig. 7. The Lower Geyser Basin area of the Firehole winter range in early spring.

sands are found in Pelican and Hayden valleys. Higher areas commonly have shallow, poorly developed soils derived from volcanic parent material interspersed with alluvial sites.

Climate

Throughout the area winters are long and cold, with short cool summers. The U.S. Department of Commerce Weather Bureau (1930-59) summary for Yellowstone National Park indicated for the headquarters' station at Mammoth, near the north boundary, a mean annual temperature of 39.8°F. January, the coldest month, averaged 18.0°F; July, with a mean of 62.8°F, was the warmest. Temperatures at this station average about 5°F higher than those for most of the park.

The same summary indicated that average annual precipitation in the study area varied from 13.73 inches at Lamar to 38.26 inches at Bechler. Near Pelican, the annual average was 19.00 inches. Most precipitation occurred as snow. For most of the park, between the 7000- and 8500-foot levels, the average snowfall was about 150 inches, with Lamar averaging 85-95 inches, and Lake, near Pelican, averaging 146 inches. For a 50-year period at Lake, a range in snowfall of 81-270 inches

is recorded. Actual depth on the ground at Lake, as recorded by snow survey measurements (U.S. Department of Agriculture—Soil Conservation Service, 1919-67), averaged about 19 inches for 1 January and about 35 inches by 1 April. Lamar would usually have somewhat less; Bechler, somewhat more. Crusting conditions, for which no record is available, varied considerably.

Seasons of the year vary with location and altitude. Warm sites near thermal activity are snow-free earlier and have a longer growing season than surrounding areas. Winter extended from mid-November to mid-April in all areas of the study. Spring began in mid-April in Lamar, in mid-May in the higher valleys, and on 1 July at the highest elevations. Summer began 1 July in the valleys, late July in the mountains. Killing frosts are usual in most locations before the end of August, so fall extended from 1 September to mid-November in all areas. At higher elevations, snow depth was often considerable by early November.

Vegetation

Vegetation types were not mapped for purposes of this study. Figure 1 indicates the extent of the larger meadows within the forested parts of the study area. More detail is apparent in Figs. 30 and 31, which show subunits of the study area. Major species of plants, according to site, are

Fig. 8. Summer range on the western part of the Pitchstone Plateau.

listed in Table 1. General descriptions of park vegetation are provided by Bailey (1930), Bailey and Bailey (1949), and McDougall and Baggley (1956). Common and scientific names used are listed in Appendix I. These follow Booth (1950) or Booth and Wright (1959).

The large, open valleys of Lamar, Pelican, Hayden, and Firehole have dense sedge growth bordering the streams and extending across the flat bottoms. The slightly higher slopes and levels support bunchgrasses, forbs, and sagebrush, with scattered marshy swale areas. Shrubs, except sagebrush, are of limited extent generally in these valleys. In Lamar, willow was grubbed out in some places to increase the area of pasture and hay land during early Buffalo Ranch operations. Extensive grassland and sagebrush areas on high slopes and ridges are particularly common in the northeast quarter, although patches of more lush herbaceous vegetation are frequent.

Much of the study area is forested, predominantly by lodgepole pine, which varies from dense, even-age growth with little understory to open stands with considerable sedge and grass. Dense shrubby undergrowth is usually not extensive. Down timber is common. At higher elevations, Engelmann spruce and alpine fir replace the lodgepole. Whitebark pine is found in some locations. Meadows are scattered throughout the forest on moist sites along streams and around ponds, and appear as small openings in drier locations. Particularly on the Mirror Plateau, boggy side hills with dense sedge growth are numerous.

On the upper plateau levels and mountain slopes, subalpine meadows are found. Above these, at the highest elevations, alpine vegetation occurs to a limited extent.

History

Yellowstone National Park was established in 1872, before the surrounding area became the states of Idaho, Montana, and Wyoming. Boundary changes, made twice, added small areas to the original rectangle and altered the east boundary in 1929 to conform for most of its length to the drainage divide formed by the Absaroka Mountains. Most of the land adjacent to the boundary is administered by the U.S. Forest Service.

Haines (1963) summarizes the history of man's occupation of the Yellowstone Plateau. Prehistoric hunters and gatherers used the area extensively. Members of several tribes of modern Indians were primarily summer hunters, although a few sheep-eaters lived a marginal existence throughout the year. Hostile Indians did not travel the park after the Bannock War of 1878, but hunting parties from

TABLE 1. *Vegetation of the study area.*

Vegetation type	General distribution	Characteristic vegetation	Associated plants	
Marsh	Alluvial soils along watercourses, swale areas	Tufted Hairgrass-Sedge Sedge-Bluegrass	Rush Shrubby Cinquefoil	
Sagebrush-Grassland	Glacial outwash areas, alluvial fans, lacustrine deposits	Big Sagebrush	Wheatgrass Idaho Fescue Balsamroot	Lupine Eriogonum Dryland Sedges
Upland Forest	Various substrates and exposures up to 10,000 ft.	Lodgepole Pine Engelmann Spruce-Subalpine Fir Whitebark Pine	Dwarf Huckleberry Arnica Lupine Pinegrass	
Forest Park	Alluvial soils along watercourses, old ponds, small openings on drier slopes	Sedge-Tufted Hairgrass Idaho Fescue-Wheatgrass Mountain Brome-Slender Wheatgrass	Rush Dandelion Lupine Cinquefoil Bluegrass	
Herbland	Fine-textured residual soils of mountain slopes from about 8000 to 9500 ft.	Mountain Brome-Slender Wheatgrass	Lupine Cinquefoil Geranium	Bluegrass Needlegrass Rush
Subalpine Meadow	Mountain slopes and ridgetops, mainly above 8500 ft.	Tufted Hairgrass-Sedge	Rush Bluegrass Wild Barley	

reservations were known at the park fringes as late as 1893 (Hough 1894). Although few left written accounts, trappers, beginning with John Colter in 1807, visited the area many times before the end of the fur trade in 1840. Miners and explorers followed.

The park was not subject to settlement, and there were few people for some years after its establishment. With the exception of a few early squatters, developments were for administrative use or concessioner operation. In conjunction with these, horses and cattle were grazed in some places, and wild hay was cut. Disturbance was generally minimal except in the Lamar area. Skinner and Alcorn (1942-51) summarize the Buffalo Ranch-Lamar Ranger Station operations of Lamar and Slough Creek valleys from 1907 through 1951. Seeding and irrigation practices were part of the haying program, as well as construction of buildings, fences, and other necessities of a ranch.

During the early years of the park, wildlife had little protection. The Act establishing Yellowstone National Park provided only that wildlife should not be "wantonly destroyed" nor subject to "capture and destruction for the purposes of merchandise or profit." Until 1887 official regulations permitted hunting while traveling in the park. Legal means for enforcing regulations were lacking, although the Army troops stationed in the park after 1886 did what they could. Attempts at protection had limited effect until passage of the Lacey Act in 1894 provided legal machinery and jurisdictional authority for dealing with violators. Outside the park, ineffective laws contributed to poaching within the boundaries.

Not until 1901 did the Superintendent of the park believe the laws of all three surrounding states were such that the wild bison left in Yellowstone might be effectively protected, but their numbers were so few that survival seemed doubtful. Intensive management of an introduced herd began in 1902 to ensure survival of some bison in Yellowstone. For a time the animals lived in semidomestication, and were fed hay and tended almost like a herd of cattle. Management policy gradually changed to one of minimal interference by man, which continues in spite of the impact of steadily increasing numbers of tourists. The present (1970) bison population is completely wild and unfettered by fencing or artificial management.